

Unit 41: Highway Engineering

Level:	5
Credits:	15
Ofqual Code:	D/618/8118

Introduction

The quick and flexible means of transport afforded to us by motor vehicles has transformed modern life. This ease of mobility is made possible by the construction and maintenance of our road system. The increased volume of traffic and the need to have an efficient road network to transport resources requires us to become more proactive in developing innovative highway solutions. In recent years, we have seen the introduction of 'smart motorways' and 'guided busways', however we require more creative and resourceful solutions for the future.

This unit explores the planning, design, construction and maintenance of our road infrastructure, including the supporting structures such as tunnels, bridges and full pavement construction.

On successful completion of this unit, students will be able describe a new route process for a highway and explain civil engineering aspects, including pavement types. They will also be able to appraise improvements to the existing road infrastructure.

Learning Outcomes

By the end of this unit, students will be able to:

- LO1 Evaluate how a new highway route is identified, planned and designed
- LO2 Assess the methods of earthwork operations, bridges and tunnelling used in connection with the provision of highways
- LO3 Specify a form of pavement construction for a given highway provision
- LO4 Present a proposal for improvements that can be made to a given highway infrastructure, including maintenance techniques and planning.

Essential Content

LO1 Evaluate how a new highway route is identified, planned and designed

Highway identification and planning

Assessment of traffic volumes

Variables affecting traffic volumes

Land acquisition procedures (including alignment design)

Public consultation (e.g., environmental impact assessment, public meetings, statutory requirements, health and safety)

Funding arrangements (e.g., proposed tolls, taxes)

Highway design

Horizontal and vertical alignment

Environmental impact assessment requirements

Proposed assessment of interchanges with existing infrastructure (including bridges, tunnels and junctions)

Provision and integration of any electronic toll collection infrastructure

Drainage systems (including sustainable urban drainage systems)

Highway users and user needs (e.g., general public, heavy goods vehicles, emergency use, access and maintenance)

LO2 Assess the methods of earthwork operations, bridges and tunnelling used in connection with the provision of highways

Earthwork operations methods

Cut and fill balancing

Ground stabilisation techniques (e.g., lime injection, geogrid, retaining walls, specialist plant required)

Forming of embankments (retaining walls, angle of repose, stabilisation)

Engineering control of earthwork operations

Formation testing

Bridges

Formation of abutments
Active and passive span arrangement
Bridge deck and bearing details to be used
Architectural requirements of the structures
Typical types of highway bridges used

Tunnel provision

Formation of tunnel (e.g., cut and cover, pipe jacking, boring)
Boring machinery
Soils conditions
Proposed destination for surplus material
Maintenance arrangements
Materials used for tunnel linings

LO3 Specify a form of pavement construction for a given highway provision

Flexible pavement construction

Materials (e.g., dense bitumen macadam, high-density macadam, pervious macadam, mastic asphalt, hot rolled asphalt)
Properties and uses of aggregates
Common construction methods
Environmental performance
Skid resistance
Deterioration
Sub-base materials

Rigid pavement construction

Concrete (e.g., mix details, reinforcement, joint details)
Use of pavement trains
Environmental performance
Skid resistance
Deterioration
Sub-base materials

LO4 Present a proposal for improvements that can be made to a given highway infrastructure, including maintenance techniques and planning

Improvement to existing highway infrastructure

Use and effectiveness of 'smart' motorways

Utilisation of redundant infrastructure

Traffic management systems

Technology to improve public transport systems

Safety measures

Maintenance planning and techniques

Common degradation processes for highway structures

Essential or routine repair to concrete supporting infrastructure

Renewing worn out pavement surfaces

Repair schedule and asset management (e.g., surveying road conditions, digital asset management)

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Evaluate how a new highway route is identified, planned and designed		D1 Critically analyse the properties of materials required for structural application in bridges and tunnels.
P1 Discuss how the route of a new section of highway is identified and planned. P2 Explain the role of public consultation in higher planning.	M1 Analyse the relationship between highway use and traffic volumes.	
LO2 Assess the methods of earthwork operations, bridges and tunnelling used in connection with the provision of highways		
P3 Analyse the earthwork operations required for construction of a new highway in a developed area with difficult terrain. P4 Review the earthwork processes involved in the formation of tunnels and bridges for a new highway.	M2 Evaluate the need for ground stabilisation associated with bridge and tunnel construction for a new highway.	
LO3 Specify a form of pavement construction for a given highway provision		D2 Justify the specification of a pavement type for a new highway, based on performance characteristics.
P5 Assess the requirements of a given highway construction proposal. P6 Specify the pavement type for a new highway construction.	M3 Compare flexible and rigid pavement construction for a new highway.	
LO4 Present a proposal for improvements that can be made to a given highway infrastructure, including maintenance techniques and planning		D3 Critically evaluate proposed improvements to a highway infrastructure scheme to identify alternative approaches to improve performance and reliability.
P7 Present improvements to a given existing and new highway provision. P8 Discuss common highway faults and effective maintenance regimes as preventative measures for a given project.	M4 Assess the techniques and methods that may improve the effectiveness and conditions of a given highway project.	

Recommended Resources

Print resources

HUGHES, D., O'FLAHERTY, C. (2015), *Highways*, ICE Publishing

MANNERING, F., WASHBURN, S. (2020), *Principles of Highway Engineering and Traffic Analysis*, John Wiley & Sons

ROGERS, M., ENRIGHT, B. (2016), *Highway Engineering*, John Wiley & Sons

SOMAYAJI, S. (2001), *Civil Engineering Materials*, Pearson College Division

WATSON, J. (1994), *Highway Construction and Maintenance*, Halsted Press

Web resources

<https://bit.ly/2V5h1Ou>

Chartered Institution of Highways & Transportation
(Professional Body)

<https://bit.ly/3f9iKKG>

Highways England
(General Reference)

<https://bit.ly/3f5Hovj>

The Institute of Highways Engineers
(Professional Body)